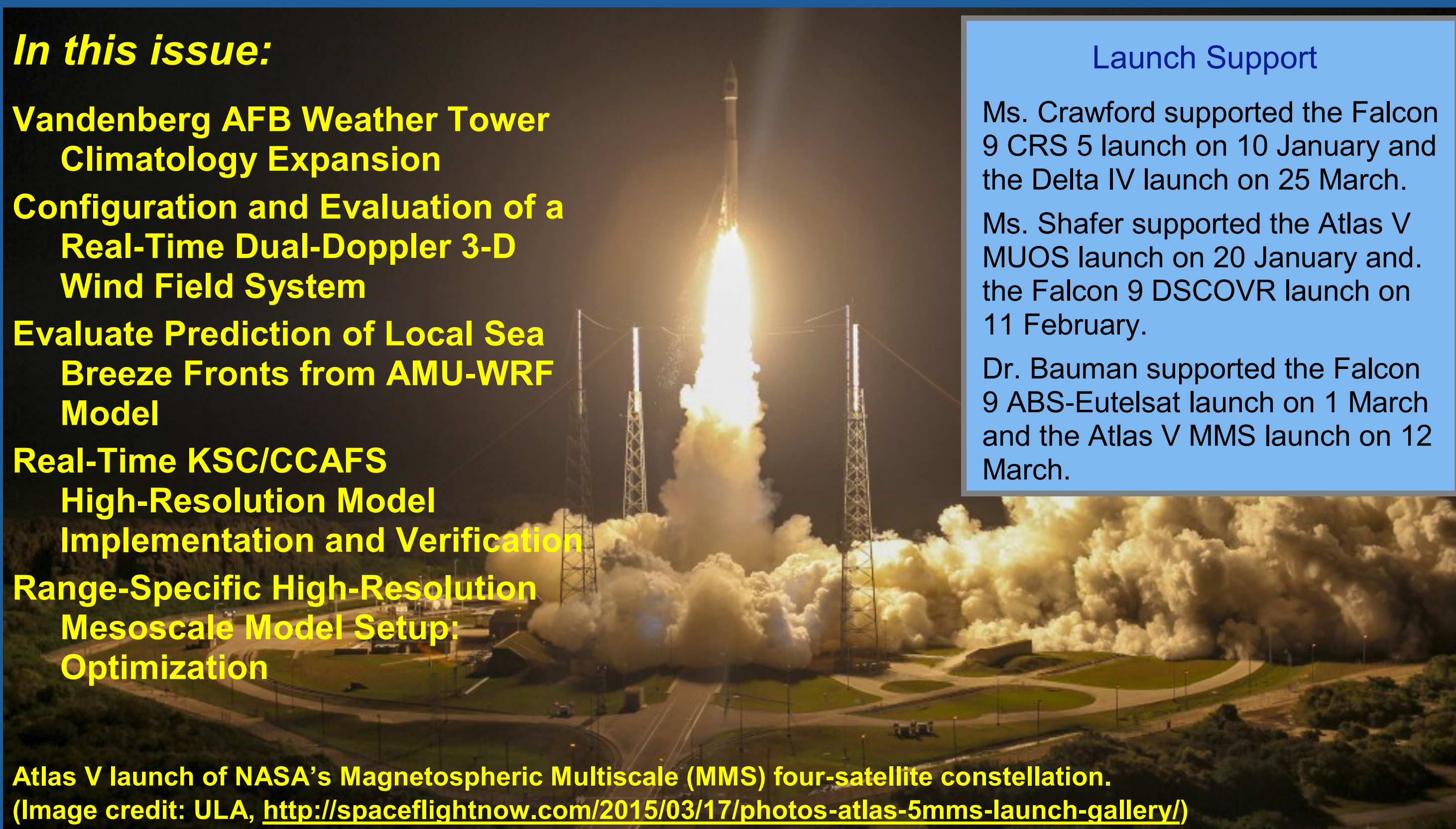
AMU Applied Meteorology Unit

Infusing Weather Technology Into Aerospace Operations

Quarterly Report
Second Quarter FY-15
30 April 2015

Contract NNK12MA53C/DRL-003 DRD-004
Report, Final Task Reports DRL-005



In this issue:

Launch Support

Ms. Crawford supported the Falcon 9 CRS 5 launch on 10 January and the Delta IV launch on 25 March.

Ms. Shafer supported the Atlas V MUOS launch on 20 January and. the Falcon 9 DSCOVR launch on 11 February.

Dr. Bauman supported the Falcon 9 ABS-Eutelsat launch on 1 March and the Atlas V MMS launch on 12 March.

Atlas V launch of NASA's Magnetospheric Multiscale (MMS) four-satellite constellation. (Image credit: ULA, http://spaceflightnow.com/2015/03/17/photos-atlas-5mms-launch-gallery/)

This Quarter:

- This is the last AMU Quarterly Report due to contract cancellation as of 30 April 2015. Contact Dr. Lisa Huddleston at 321-861-4952 or lisa.l.huddlestoln@nasa.gov for more information.
- Ms. Shafer began updating the weather tower climatology she developed for the 30th Operational Support Squadron (30 OSS) with data from more sensors and a longer period of record (POR).
- Ms. Crawford acquired code to ingest lightning data into the Warning Decision Support System—Integrated Information (WDSS-II) software.
- Ms. Shafer completed the final report describing the implementation and verification of the local high-resolution Weather Research and Forecasting (WRF) model.
- Dr. Bauman continued work to evaluate the AMU-WRF model's forecast of the onset, position, and movement of the local sea and river breezes, important elements in the location and timing of lightning.
- Dr. Watson continued work on a task to optimize and run in real time the WRF model she configured to assimilate observational data in a previous task.

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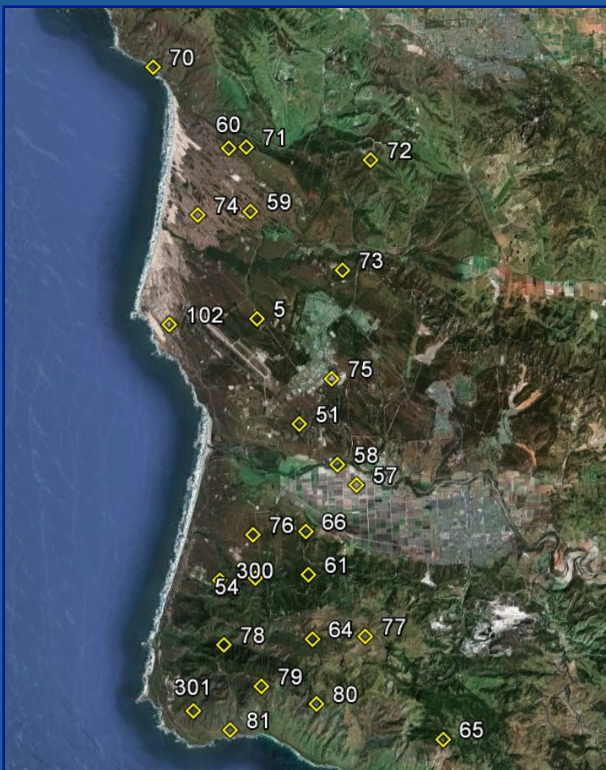
Quarterly Task Summaries

This section contains summaries of the AMU activities for the second quarter of Fiscal Year 2015 (January—March 2015). The accomplishments on each task are described in more detail in the body of the report starting on the page number next to the task name.



Vandenberg Air Force Base Weather Tower Climatology Expansion: 2015 (Page 5)

Customers: NASA's Launch Services Program (LSP)

Purpose: Update the AMU developed Weather Tower Climatology Tool (WTCT) used by the 30 OSS at Vandenberg Air Force Base (VAFB). The 30 OSS forecasters and launch weather officers currently rely on the WTCT to help with their extended forecasts and provide climatology information to their customers. Expanding the climatology database would be a tremendous benefit to all users. The expansion includes four additional sensor levels and extends the POR.

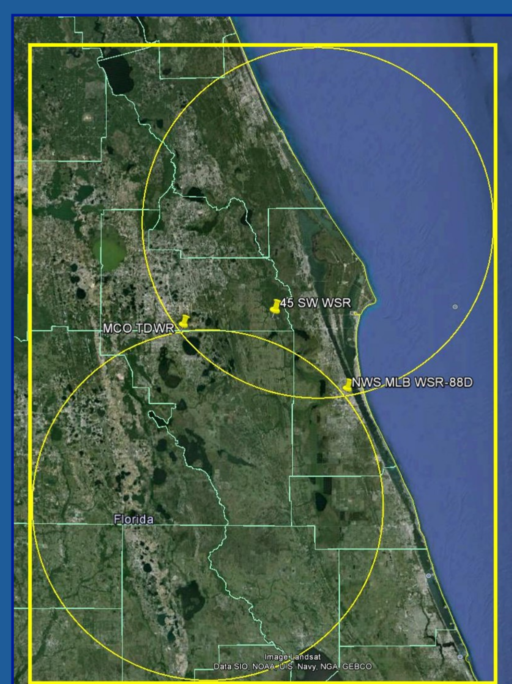
Accomplished: The 30 OSS delivered VAFB weather tower data from December 2012–February 2015. All Perl scripts needed for the tool have been updated to include the four additional sensor heights. Began extracting data needed to update the climatology database.

Configuration and Evaluation of a Real-Time Dual-Doppler 3-D Wind Field System (Page 6)

Customers: NASA's LSP, Ground Systems Development and Operations (GSDO), and Space Launch System (SLS) programs, and the National Weather Service (NWS MLB).

Purpose: Develop a real-time dual-Doppler system using freely available software to create a three-dimensional (3-D) wind field over east-central Florida using data from two local Doppler radars. Current LSP and GSDO and future SLS space vehicle operations will be halted when winds exceed defined thresholds and when lightning is a threat. A display of the wind field to reveal areas of high winds or convergence, especially over areas where no observations exist, would be useful to 45th Weather Squadron (45 WS) and NWS MLB forecasters in predicting the onset of vehicle-critical weather phenomena, and can also be used to initialize a local mesoscale numerical weather prediction model to improve the model forecast of these phenomena. A real-time dual-Doppler wind field display will aid in using ground processing and space launch resources more efficiently by stopping or starting work in a timelier manner.

Accomplished: Created merged u- and v-component files using a WDSS-II tool. Acquired software to ingest lightning data into WDSS-II.

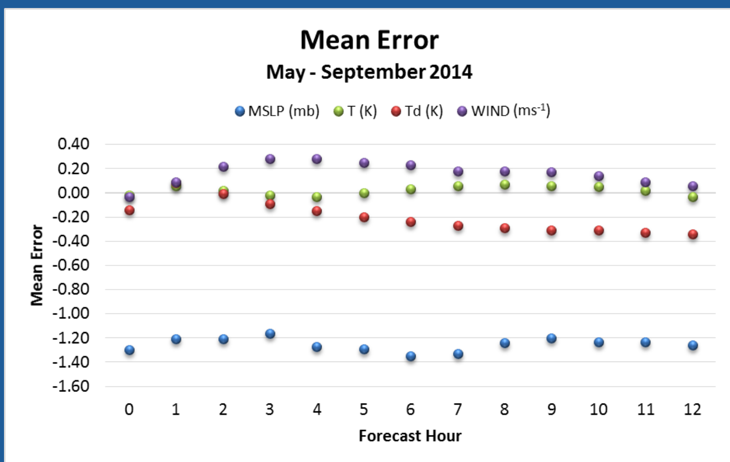


Quarterly Task Summaries
(continued)

Real-Time KSC/CCAFS High Resolution Model Implementation and Verification (Page 7)

Customers: NASA's LSP, GSDO, and SLS programs.

Purpose: Implement a real-time version of the AMU high-resolution WRF Environmental Modeling System (WRF-EMS) model developed in a previous AMU task and determine its ability to forecast the unique weather phenomena that affect NASA's LSP, GSDO, and SLS daily and launch operations on Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS). Implementing a real-time version of WRF-EMS will create a larger database of model output than in the previous task for determining model performance compared to observational data. The AMU made the model output available on the AMU and 45 WS Advanced Weather Interactive Processing System (AWIPS) for real-time subjective analysis.

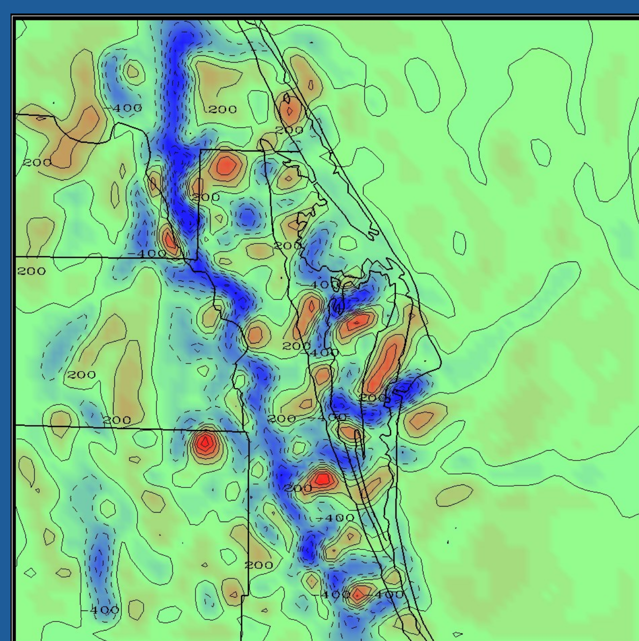


Accomplished: Conducted additional work to better understand results found for wind direction during the model verification for the 2014 warm season (May—September). Completed writing an addendum to the final report, which summarizes the latest results.

Evaluate Prediction of Local Sea Breeze Fronts from AMU-WRF Model (Page 9)

Customers: NASA's LSP, GSDO, and SLS programs.

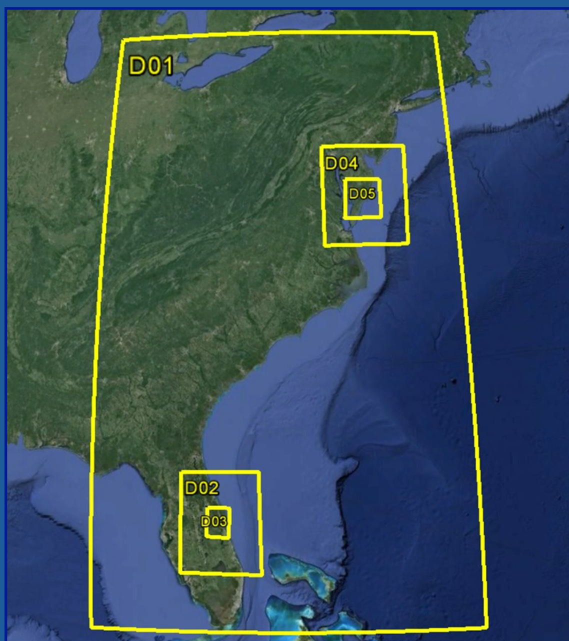
Purpose: Evaluate the performance of the 1.33- and 4-km horizontal resolution AMU-WRF model's capability to predict the onset, position, and movement of the local sea breeze and river breeze fronts. These sea breeze and river breeze fronts directly influence thunderstorm development at KSC and CCAFS during the warm season months of May to September, which directly affects NASA's SLS, LSP, and GSDO daily and launch operations. The results of this evaluation will provide guidance to the forecasters and launch weather officers (LWOs) when forecasting lightning occurrence, including timing of the first strike of the day, which is difficult to forecast during the warm season.



Accomplished: Installed open source GEneral Meteorology PAcKage (GEMPAK) software to create gridded files from KSC/CCAFS wind tower observations. Converted quality controlled (QC) wind tower observations into GEMPAK format.

Quarterly Task Summaries
(continued)

Range-Specific High-Resolution Mesoscale Model Setup—Optimization (Page 12)



Customers: NASA's LSP, GSDO, and SLS programs.

Purpose: Tune the numerical forecast model design for optimal operational performance for the Eastern Range (ER) and Wallops Flight Facility (WFF) to better forecast a variety of unique weather phenomena that affect NASA's SLS, LSP, and GSDO daily and launch operations. Global and national scale models cannot properly resolve important local-scale weather features due to their coarse horizontal resolutions. A properly tuned model at a high resolution would provide that capability and provide forecasters with more accurate depictions of the future state of the atmosphere.

Accomplished: Began running the Gridpoint Statistical Interpolation (GSI)/WRF model in real-time and displayed output in AWIPS. Began looking into the availability of hourly observation files need to run the model in a rapid-refresh mode.

AMU ACCOMPLISHMENTS DURING THE PAST QUARTER

The progress being made in each task is provided in this section, organized by topic, with the primary AMU point of contact given at the end of the task discussion.

SHORT-TERM FORECAST IMPROVEMENT

Vandenberg Air Force Base Weather Tower Climatology Expansion: 2015 (Ms. Shafer)

The 30 OSS provides comprehensive weather services to the space program at VAFB in California. One of their responsibilities is to deliver extended-range forecasts to launch customers and range safety for their day-to-day and day of launch operations. NASA's LSP and other programs operating at VAFB use these forecasts to determine if they need to limit activities or protect property such as a launch vehicle. Several agencies also request climatology data for installing equipment across the base and need to know temperature and wind extremes for particular locations before moving forward with a project.

The 30 OSS forecasters and launch weather officers currently rely on the AMU WTCT to help with their extended forecasts and provide climatology information to their customers. The 30 OSS requested the AMU expand the climatology database, which will greatly benefit all users.

Original Climatology Tool

The original WTCT (Figure 1) is a Microsoft Access tool based on the VAFB weather tower network. The network consists of 26 towers (Figure 2) and reports observations of temperature, relative humidity, average 1-minute wind speed and direction, and peak wind speed and direction. Development of this tool was discussed during the November 2012 AMU tasking Meeting and delivered in September 2013 (Shafer 2013). It includes three sensor levels (2, 4, and 16 m) and has a POR from October 2007 to November 2012. This expansion adds four sensor levels (31, 51, 62, and 91 m) and extends the POR from October 2007 to February 2015.

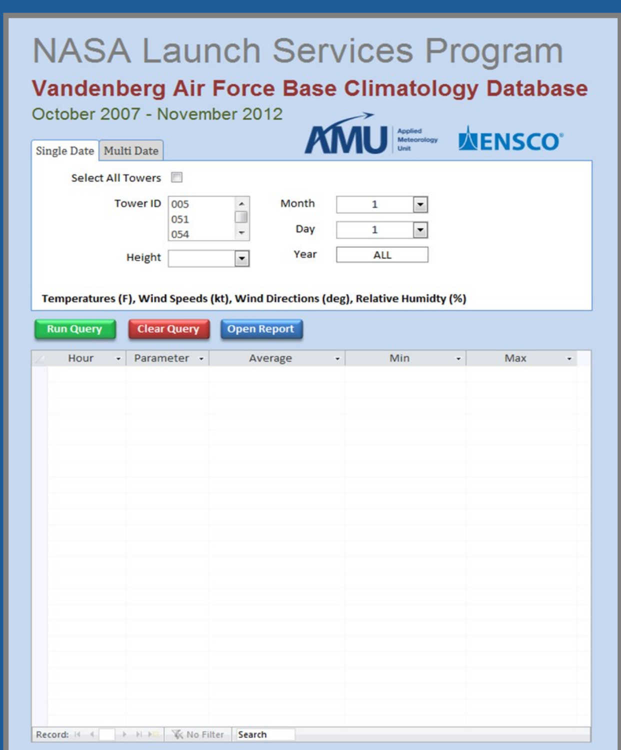


Figure 1. Main page of the original 30 OSS Weather Tower Climatology Tool.

Figure 2. Locations of the 26 towers in the VAFB network.

Climatology Database Update

Mr. Tyler Brock of the 30 OSS delivered all available data from their 26 VAFB weather towers for the December 2012 to February 2015 time period to update the existing WTCT. Ms. Shafer updated the AMU Perl scripts to read in the additional sensor levels and began processing the tower data for the climatology database. The database includes temperature (F), dewpoint (F), relative humidity (%), average 1-minute sustained wind speed (kt) and direction (degrees) and peak wind speed (kt) and direction (degrees). Ms. Shafer completed and updated the Microsoft Access tool.

Contact Dr. Lisa Huddleston at lisa.l.huddlestoln@nasa.gov or 321-861-4952 for more information.

Configuration and Evaluation of a Real-Time Dual-Doppler 3-D Wind Field System (Ms. Crawford)

Current LSP, GSDO, and future SLS space vehicle operations will be halted when wind speeds from specific directions exceed defined thresholds and when lightning is a threat. Strong winds and lightning are difficult parameters for the 45 WS to forecast, yet are important in the protection of customer vehicle operations and the personnel that conduct them. A display of the low-level horizontal wind field to reveal areas of high winds or convergence would be a valuable tool for forecasters in assessing the timing of high winds, or convection initiation and subsequent lightning occurrence. To provide this wind field, the AMU was tasked to use freely available software to create a real-time dual-Doppler analysis using data from the NWS MLB Weather Surveillance Radar–1988 Doppler (WSR-88D) and the Federal Aviation Administration (FAA) Terminal Doppler Weather Radar (TDWR) at Orlando International Airport (MCO). This task is a continuation of the AMU's just-completed Configuration and Evaluation of a Dual-Doppler 3-D Wind Field System task (Crawford 2014) in which the WDSS-II software package was tested using archived radar data. WDSS-II has been installed at NWS MLB and dual-Doppler analyses will be created using real-time data from the WSR-88D and MCO TDWR. The AMU will also investigate the ability of WDSS-II to ingest and display data from local lightning detection systems, and how to prepare the dual-Doppler wind fields for ingest to NWS MLB's local WRF model.

Velocity Merger

Ms. Crawford tried different WDSS-II command-line configurations and values for creating the velocity merger. The command to create a velocity azimuth display output separate directories for the u- and v-components of the combined velocity field, however the WDSS-II graphical user interface was not able to display the values. Ms. Crawford looked at the contents of the files, which contained what appeared to be valid u- and v-wind component values in a gridded format. She used the WDSS-II tool to convert the files to Gridded Binary-2 (GRIB2) format and will provide these to NWS MLB to determine their viability for input to their local WRF model.

Lightning Data Ingest

Ms. Crawford spoke with Dr. Rudlosky of NOAA about modules that ingest and display lightning data in WDSS-II. He emailed the modules to her and advised that one of the modules works with the Java™ version of WDSS-II. Ms. Crawford used the automated request utility on the WDSS-II website to request the Java version, but the request did not go through due to website issues. After contacting one of the WDSS-II developers, she was able to download the WDSS-II Java package from their ftp site. Due to time constraints on the AMU contract, Ms. Crawford has not been able to install WDSS-II Java and test the code sent by Dr. Rudlosky. She will deliver all software files to NWS MLB so they can continue the study.

Status

Ms. Crawford configured WDSS-II to process and display real-time WSR-88D data at NWS MLB. It has been ingesting, quality-controlling, and displaying the data without interruption since December 2014. NWS MLB must get permission from the FAA to ingest the TDWR data in order to merge its reflectivity and velocity with that of the WSR-88D.

Contact Dr. Lisa Huddleston at lisa.l.huddlestoln@nasa.gov or 321-861-4952 for more information.

Real-time KSC/CCAFS High Resolution Model Implementation and Verification (Ms. Shafer and Dr. Watson)

NASA's LSP, GSDO, SLS and other programs at KSC and CCAFS use the daily and weekly weather forecasts issued by the 45 WS as decision tools for their day-to-day and launch operations on the ER. For example, to determine if they need to limit activities such as vehicle transport to the launch pad, protect people, structures or exposed launch vehicles given a threat of severe weather, or reschedule other critical operations. The 45 WS uses numerical weather prediction models, such as the Air Force Weather Agency (AFWA) 1.67-km WRF model, as a guide for their daily and weekly weather forecasts. Considering the 45 WS forecasters' and LWOs' extensive use of the AFWA model, the 45 WS proposed a task at the September 2013 AMU Tasking Meeting requesting the AMU verify this model. Due to the lack of archived model data available from AFWA, verification is not yet possible. The AMU then proposed to implement and verify the performance of an ER version of the AMU high-resolution WRF-EMS model (Watson 2013) in real-time. The tasking group agreed to this proposal and therefore the AMU implemented the WRF-EMS model on the second of two AMU modeling clusters. The AMU then made the model output available on the AMU AWIPS servers, which allows the 45 WS and AMU staff to customize the model output display on the AMU and Range Weather Operations (RWO) AWIPS client computers and conduct real-time subjective analyses. The AMU also calculated verification statistics to determine model performance compared to observational data.

Additional Wind Speed and Direction Statistics

The model verification statistics calculated to determine the 1.33-km domain WRF-EMS model performance for the entire 2014 warm season (May-September) are discussed in the previous AMU Quarterly Report (Q1 FY15). Once the formal task was complete, Ms. Shafer conducted additional work to better understand the results found for wind direction. Initially, Ms. Shafer stratified the results diurnally to determine how the daytime/nighttime periods influenced the model wind direction. The results showed little difference between the daytime and nighttime values. Given these findings, Ms. Shafer stratified the winds by speed without the diurnal breakdown, and recalculated the statistics.

Diurnal Stratification

Ms. Shafer stratified the model forecast data into two categories of 12 daytime hours (0600-1759 EDT) and 12 nighttime hours (1800-0559 EDT) that generally conform to day and night hours in the warm season months, and calculated the Root Mean Square Error (RMSE) for wind speed and direction. Figure 3 shows the wind speed (ms^{-1}) RMSE versus model forecast hour: "All" values are in blue, "Day" values are in red and "Night" values are in green. The values for All are the same as those from the initial analysis. Figure 4 is the same as Figure 3 but for wind direction (degrees). As with wind speed, the values for All are the same as those from the initial analysis. For each forecast hour, the RMSE values for all times and both diurnal stratifications in wind speed and direction are about the same. This demonstrates that the model wind speed and wind direction forecasts for the 2014 warm season were not influenced by diurnal effects.

Speed Stratification

Since the diurnal results did not give insight into the model forecast wind direction behavior, Ms. Shafer stratified the data by wind speed cat-

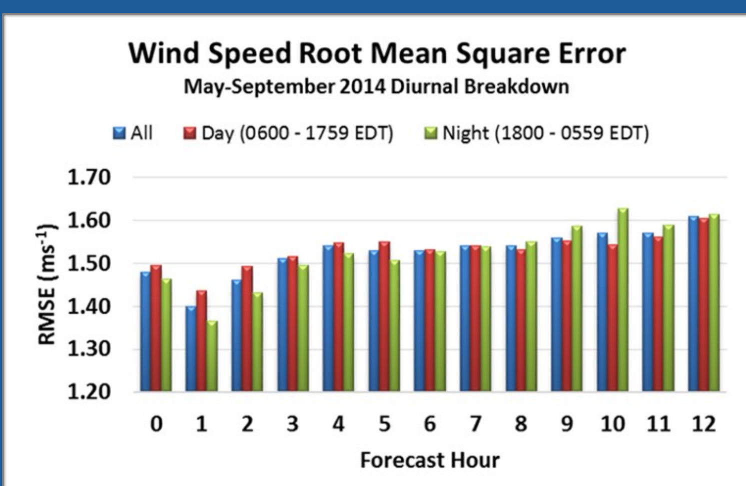


Figure 3. Wind speed (ms^{-1}) RMSE versus model forecast hour stratified diurnally. All values are in blue, Day values (0600-1759 EDT) are in red and Night values (1800-0559 EDT) are in green.

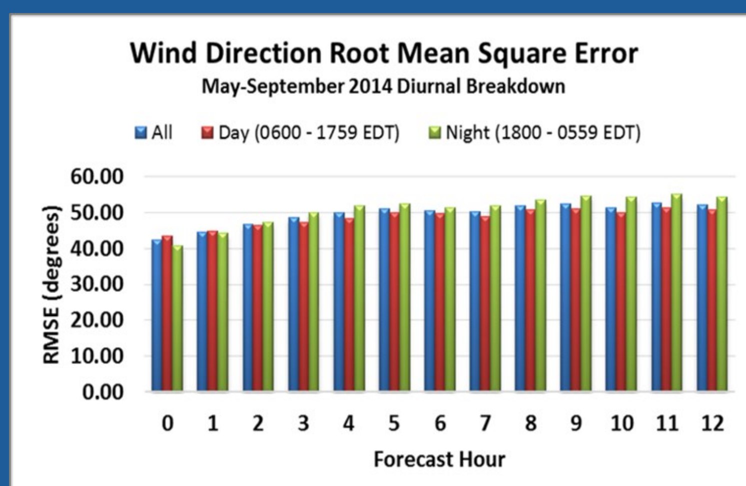


Figure 4. Same as Figure 3 but for wind direction (degrees).

Wind Category	Forecast Hour												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
<5 ms^{-1}	2966	2925	2852	2807	2833	2861	2757	2661	2538	2390	2286	2150	2004
5–10 ms^{-1}	405	443	512	552	528	497	462	416	404	403	373	366	372
>10 ms^{-1}	0	0	2	5	4	4	5	7	3	5	5	6	4

Table 1. List of model forecast wind speed sample sizes for each category per model forecast hour.

egories to determine if this would show differences in the wind direction RMSEs. Three categories were selected: "<5 ms^{-1}" is considered light and variable, "5-10 ms^{-1}" is considered moderate and ">10 ms^{-1}" is considered strong winds. Table 1 shows the wind speed categories and their associated sample sizes for each forecast hour. Note that the sample sizes for the >10 category are below 10 regardless of forecast hour, too small to calculate meaningful statistics. Therefore, this category was not used for the model forecast wind direction verification. The other two categories, however, have enough samples with which to calculate a robust RMSE.

Figure 5 shows the wind speed (ms^{-1}) RMSE versus forecast hour for each wind category. "All Speeds" is in purple, "<5" is in blue and "5-10" is in red. The values for All Speeds are the same as those from the initial analysis. Regardless of forecast hour, the RMSE remains ≤2 ms^{-1} for all three categories. The values for the 5-10 category are slightly higher than the other two categories. Nonetheless, these are small differences between the forecast and observations considering the normal magnitude of the parameter.

Figure 6 is the same as Figure 5 but for wind direction where, again, the values for All Speeds are the same as those from the initial analysis. This chart clearly shows the wind direction RMSE from the All Speeds category is highly influenced by the <5 category. The light winds in this category tend to have more variability in their direction that can result in greater forecast error. The higher winds in the 5-10 category tend to have a more stable direction and are therefore easier to forecast. The RMSE for this moderate wind category ranged from 15-40 degrees, which is about 20 degrees less than the RMSEs of the All Speeds and <5 categories.

Final Report

Ms. Shafer completed writing the addendum to the final report. It was reviewed internally by the AMU and submitted for NASA Export Control approval. The approval was received and the report is now posted on the AMU website.

Contact Dr. Lisa Huddleston at lisa.l.huddlestoln@nasa.gov or 321-861-4952 for more information.

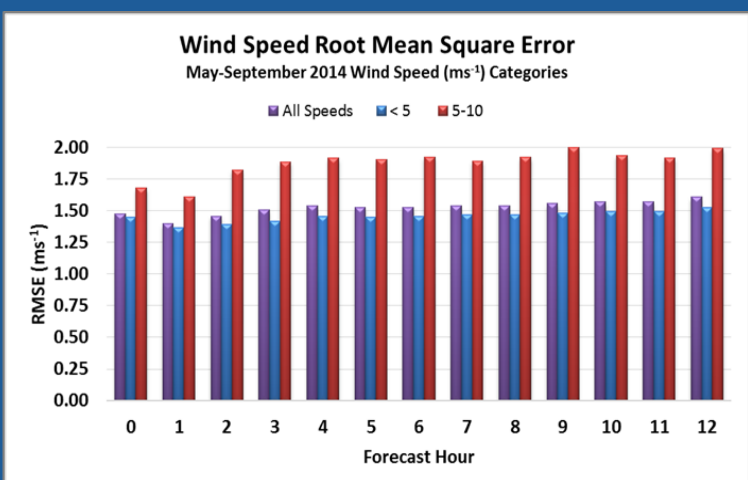


Figure 5. Wind speed (ms^{-1}) RMSE versus model forecast hour stratified by wind speed. The All Speeds category is in purple, <5 is in blue and 5–10 is in red.

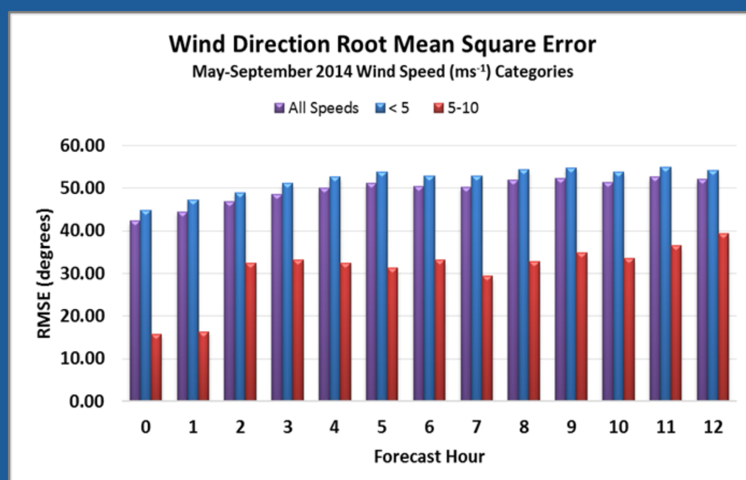


Figure 6. Same as Figure 3 but for wind direction (degrees).

Evaluate Prediction of Local Sea Breeze Fronts from AMU-WRF Model (Dr. Bauman)

The AMU is producing real time high-resolution AMU-WRF numerical weather prediction model output to provide more accurate and timely forecasts of unique weather phenomena that can affect NASA's SLS, LSP, and GSDO daily operations and space launch activities. One AMU-WRF product developed by the AMU is a depiction of the local sea and river breezes based on the model's forecast of surface convergence and low-level winds. During the warm season months of May to September, daily lightning-producing convection at KSC and CCAFS is highly correlated to the onset, position, and movement of the sea and river breeze fronts. High-confidence, high-precision prediction of the onset of sea and river breezes in the KSC/CCAFS area during the warm season is difficult. However, precise prediction of sea and river breeze onset, position, and movement is important to forecasting the first lightning of the day, lightning progression, and wind flows for toxic corridor prediction by 45th Space Wing (45 SW) Range Safety during launch windows.

Anecdotally, the 45 WS LWOs and forecasters believe the AMU-WRF sea breeze product performed well during the 2014 warm season. In order to quantify the model's capability, the 45 WS tasked the AMU evaluate the performance of the 1.33- and 4-km horizontal resolution AMU-WRF model in predicting the onset, position, movement, and intensity of sea and river breeze fronts in the KSC/CCAFS area during the 2014 warm season.

Data Processing

Creating convergence/divergence maps based on the wind tower network observations requires converting the observational data to gridded data, and then performing a Barnes objective analysis (Barnes 1973) on the gridded data. Previously, Dr. Bauman assessed three open source software programs (AMU Quarterly Report Q1 FY15). After selecting and processing several test files using the Integrated Data Viewer software, Dr. Bauman realized it would be easier to use the GEMPAK built-in divergence function and use scripting to automate and more efficiently process the observational data files using GEMPAK software.

Upon installing GEMPAK on an AMU PC, Dr. Bauman converted the wind tower observation files into a format that GEMPAK could import. Since GEMPAK can import comma separated value (csv) files, he wrote a Visual Basic for Applications (VBA) script in Excel to reformat the previously QC'd monthly wind tower observation text files into csv files. There are 159 monthly files, one for each wind tower 54-ft sensor and each warm season (May—September) month. The VBA script converted the monthly files into 992 daily files, one for each wind tower. Next, the script created 12,098 15-minute files with each file containing all wind towers. Finally, the script reformatted the 15-minute files and saved them as csv files for import into GEMPAK. A sample csv file from 24 May 2015 at 1530 UTC is shown in Table 2. The first row must identify the meteorological parameters included in the observations in the order they appear in each subsequent row. The parameters for all 15-minute files included wind speed in kt (SKNT), wind direction in degrees (DRCT), u-component of the wind (UWND), and v-component of the wind (VWND). The next 28 rows with data include the 8-character tower identifier; year, month, day, and UTC time of the observation; SKNT; DRCT; UWND; and VWND. Missing data is indicated by -9999.

Table 2. Sample csv wind tower observation file formatted for import into GEMPAK.

```
PARM = SKNT;DRCT;UWND;VWND

T0000001,140524/1530,6,99,-5.926,0.939
T0000003,140524/1530,5,50,-3.83,-3.214
T0000019,140524/1530,3,17,-0.877,-2.869
T0000020,140524/1530,4,103,-3.897,0.9
T0000022,140524/1530,-9999,-9999,-9999,-9999
T0000061,140524/1530,6,32,-3.18,-5.088
T0000108,140524/1530,5,349,0.954,-4.908
T0000211,140524/1530,2,6,-0.209,-1.989
T0000300,140524/1530,3,46,-2.158,-2.084
T0000303,140524/1530,4,44,-2.779,-2.877
T0000311,140524/1530,7,6,-0.732,-6.962
T0000403,140524/1530,3,346,0.726,-2.911
T0000412,140524/1530,7,355,0.61,-6.973
T0000415,140524/1530,3,312,2.229,-2.007
T0000418,140524/1530,4,41,-2.624,-3.019
T0000421,140524/1530,4,344,1.103,-3.845
T0000506,140524/1530,3,311,2.264,-1.968
T0000509,140524/1530,3,339,1.075,-2.801
T0000714,140524/1530,5,318,3.346,-3.716
T0000803,140524/1530,4,319,2.624,-3.019
T0000819,140524/1530,4,340,1.368,-3.759
T0001000,140524/1530,-9999,-9999,-9999,-9999
T0001007,140524/1530,4,46,-2.877,-2.779
T0001012,140524/1530,2,327,1.089,-1.677
T0001101,140524/1530,4,343,1.169,-3.825
T0001204,140524/1530,2,39,-1.259,-1.554
T0003131,140524/1530,7,329,3.605,-6
T0009404,140524/1530,4,47,-2.925,-2.728
```

Since towers 002, 006, 110, and 313 have dual sensors on the southeast (SE) and northwest (NW) sides of the tower at 54 ft, one sensor from each tower had to be eliminated for each 15-minute interval in order for GEMPAK to properly compute divergence after the wind tower observations were transformed onto a grid by GEMPAK. Figure 7 depicts which sensor is chosen to report real-time observations to the forecaster based on the observed wind direction. The NW sensor is always used when the winds are between 249° and 22° (thick light red arc) and the SE sensor is always used when the winds

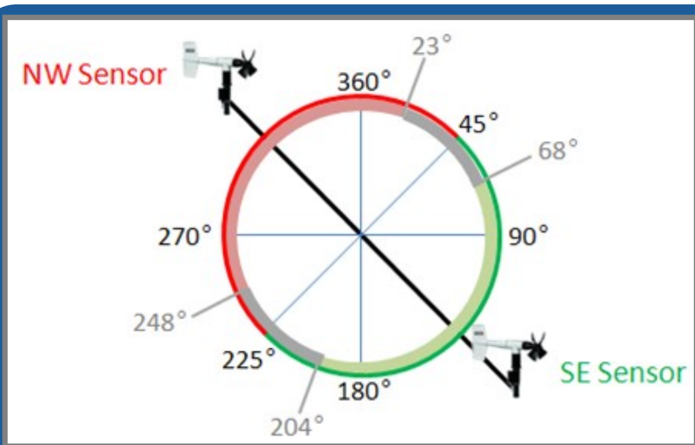


Figure 7. Dual-sensor configuration on towers 002, 006, 110, and 313. Sensors are mounted on the NW and SE side of each tower. The NW sensor is always selected when the winds are between 249° and 22° (light red arc) and the SE sensor is always selected when the winds are between 69° and 203° (light green arc). Either sensor can be used in the two gray regions when the winds are between 23° and 68° or 204° and 248°.

are between 69° and 203° (thick light green arc). However, both sensors can display observations in the gray arcs, 23° to 68° or 204° to 248°. The sensor used in the gray arc is based on the last sensor used before the winds were in the gray arc. For example, if the SE sensor was the previously selected sensor based on wind direction, then that sensor will continue to be the selected sensor until winds are observed between 248° and 23°. Conversely, if the NW sensor was the previously selected sensor, it will remain so until the winds are observed between 68° and 204°. For this task, the NW sensor was used for winds between 226° and 45° (thin red arc in Figure 7) and the SE sensor was used for winds between 46° and 225°(thin green arc in Figure 7).

In order for GEMPAK to create gridded files from the wind tower observation files, it must first create a GEMPAK surface file. To create a GEMPAK surface file requires running the GEMPAK program SFCFIL, which requires the following input parameters:

- SFOUTF Output surface file
- SFPRMF Surface parameter packing file
- STNFIL Station information file
- TIMSTN Times/additional stations

The output surface file, SFOUTF, is generated by GEMPAK when SFCFIL is executed. The surface parameter packing file, SFPRMF, contains the meteorological parameters specified by the wind tower observation file (SKNT, DRCT, UWND, and VWND). The station information file, STNFIL, is a text file that contains station information to include the character identifier, number, name, state, country, latitude, longitude and elevation for each station. Parameters in a station information file must be stored using the exact format used by GEMPAK tables, since they are read with a FORTRAN format statement. Dr. Bauman created the station information file for the wind towers as shown in Table 3. No column headers are required but each parameter must be in the correct order for GEMPAK to import the file. The times/additional stations parameter, TIMSTN, specifies the maximum number of times to be included in the GEMPAK surface file.

After creating a GEMPAK surface file, the GEMPAK program SFEDIT must be executed to add or change data in a surface file using a sequential text file, which in this case is a wind tower observation file. SFEDIT requires the following two input parameters:

- SFEFIL Surface edit file
- SFFILE Surface data file

The surface edit file, SFEFIL, is the csv file containing the wind tower observations for one 15-minute observa-

Table 3. Station table file containing wind tower identifier, number (99999), name (WIND TOWER), State (FL), country (US), latitude (deg), longitude (deg), and elevation (m).

T0000001	99999	WIND TOWER	FL	US	2843	-8057	16
T0000003	99999	WIND TOWER	FL	US	2846	-8053	16
T0000019	99999	WIND TOWER	FL	US	2874	-8070	16
T0000020	99999	WIND TOWER	FL	US	2844	-8056	16
T0000021	99999	WIND TOWER	FL	US	2844	-8056	16
T0000022	99999	WINDTOWER	FL	US	2880	-8074	16
T0000061	99999	WIND TOWER	FL	US	2851	-8056	16
T0000062	99999	WIND TOWER	FL	US	2851	-8056	16
T0000108	99999	WIND TOWER	FL	US	2854	-8058	16
T0000211	99999	WIND TOWER	FL	US	2861	-8062	16
T0000300	99999	WIND TOWER	FL	US	2841	-8065	16
T0000303	99999	WIND TOWER	FL	US	2846	-8057	16
T0000311	99999	WIND TOWER	FL	US	2860	-8064	16
T0000403	99999	WIND TOWER	FL	US	2846	-8059	16
T0000412	99999	WIND TOWER	FL	US	2861	-8067	16
T0000415	99999	WIND TOWER	FL	US	2866	-8070	16
T0000418	99999	WIND TOWER	FL	US	2871	-8073	16
T0000421	99999	WIND TOWER	FL	US	2878	-8080	16
T0000506	99999	WIND TOWER	FL	US	2852	-8064	16
T0000509	99999	WIND TOWER	FL	US	2856	-8067	16
T0000714	99999	WIND TOWER	FL	US	2864	-8075	16
T0000803	99999	WIND TOWER	FL	US	2846	-8067	16
T0000819	99999	WIND TOWER	FL	US	2875	-8087	16
T0001000	99999	WIND TOWER	FL	US	2841	-8076	16
T0001007	99999	WIND TOWER	FL	US	2853	-8077	16
T0001012	99999	WIND TOWER	FL	US	2861	-8083	16
T0001101	99999	WIND TOWER	FL	US	2857	-8059	16
T0001102	99999	WIND TOWER	FL	US	2857	-8059	16
T0001204	99999	WIND TOWER	FL	US	2848	-8079	16
T0003131	99999	WIND TOWER	FL	US	2863	-8066	16
T0003132	99999	WIND TOWER	FL	US	2863	-8066	16
T0009404	99999	WIND TOWER	FL	US	2834	-8073	16

tion time. The surface data file, SFFILE, is the file created by GEMPAK after executing the SFCFIL program as previously discussed. Executing SFEDIT extracts the wind tower observations contained in SFEFIL and adds them to SFFILE for display or further processing by GEMPAK.

To verify the tower observations were in GEMPAK format, Dr. Bauman executed the GEMPAK program SFMAP, which can plot observations on a map created from SFCFIL and SFEDIT. Figure 8 shows a GEMPAK-generated map from 24 May 2014 at 1530 UTC of wind barbs from the wind towers.

Before being able to display divergence based on the wind tower observations, a Barnes objective analysis must be performed on the observations. To do so in GEMPAK, the first step is to create a gridded file of the wind tower observations using the GEMPAK program OAGRID. The following are OAGRID input parameters:

- GDFILE Grid file
- DELTAN Average station spacing in degrees latitude
- DELTAX X spacing in degrees longitude
- DELTAY Y spacing in degrees latitude
- GRDAREA Area covered by grid
- EXTEND Points to extend grid
- DTAAREA Data area for OA
- SOURCE Data source (SN or SF)
- SNFILE Sounding data file
- SFFILE Surface data file
- SNPARM Sounding parameter list
- SFPARM Surface parameter list
- DATTIM Date/time
- LEVELS Vertical levels
- MAXGRD Maximum number of grids

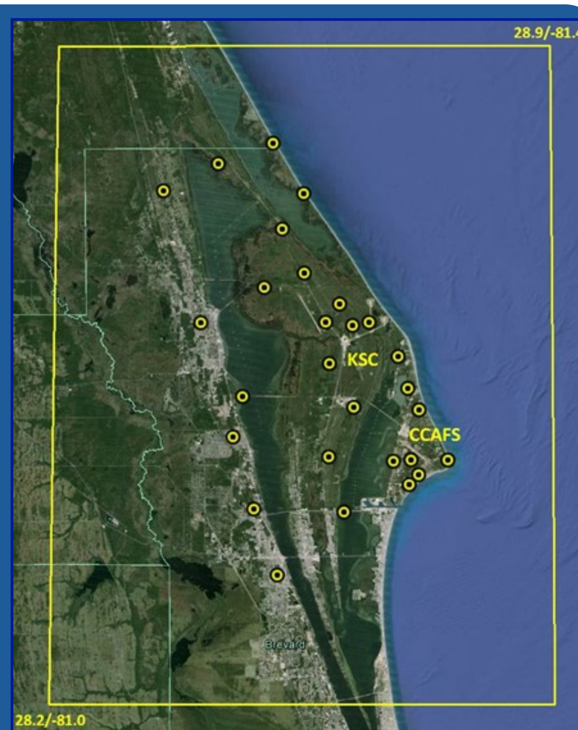


Figure 9. Yellow box showing area used by the GEMPAK program OAGRID to create a grid from the wind tower observations. The yellow circles show the locations of the wind towers.

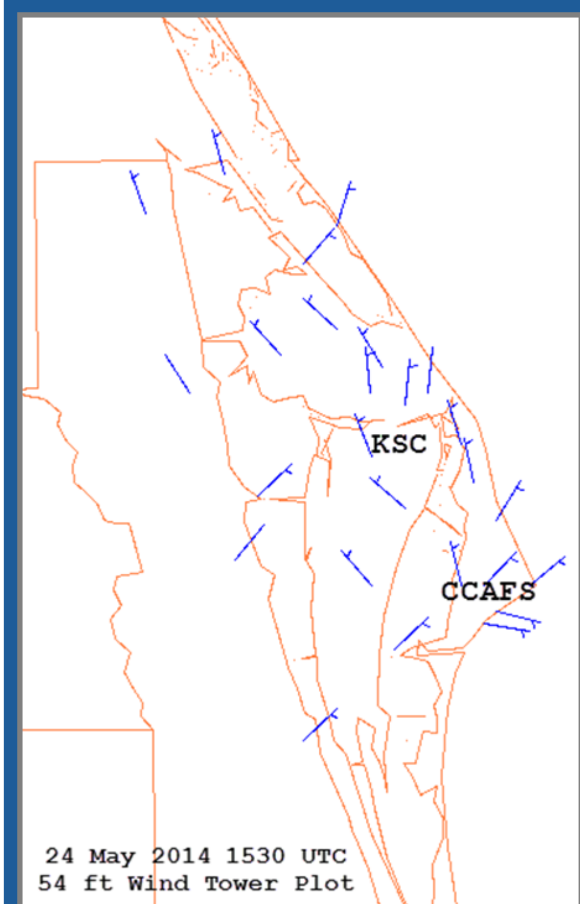


Figure 8. GEMPAK plot of wind barbs (blue) of wind tower observations from 24 May 2014 at 1530 UTC.

The OAGRID program will create the grid file, GDFILE, which uses the surface file, SFFILE, created by the SFEDIT program and contains the wind tower observations. Dr. Bauman used the default settings for average station spacing (DELTAN) of 0.15, and grid spacing (DELTAX and DELTAY) of 0.08. He chose the area covered by the grid (GRDAREA) to include a lower left latitude/longitude corner at 28.2°/-81.0° and an upper right corner at 28.9°/-80.4° as shown by the yellow box in Figure 9.

After running OAGRID, Dr. Bauman ran the Barnes objective analysis program in GEMPAK, OABSFC. The following are OABSFC input parameters:

- SFFILE Surface data file
- GDFILE Grid file
- SFPARM Surface parameter list
- DATTIM Date/time
- DTAAREA Data area for OA
- GUESS Guess file
- GUESFUN Guess grid
- GAMMA Convergence parameter
- SEARCH Search radius/ Extrapolation
- NPASS Number of passes
- QCNTL Quality control threshold
- OABND Bounds file(s) to use for 'blocking'
- GDATTIM Grid date/time
- GFUNC Scalar grid
- GLEVEL Grid level
- GVCORD Grid vertical coordinate

The OABSFC program uses the two files containing the wind tower data, SFFILE and GDFILE, for the objective analysis. For the surface parameter list, Dr. Bauman chose wind arrows from the tower observations to overlay on the gridded divergence field. The data area, DTAAREA, was the same as used in

OAGRID and shown in Figure 9. Dr. Bauman used the default convergence parameter, GAMMA, set to 0.3, which is a multiplier for the weight and search radius for passes after the first pass of OABSFC. The search radius weighting factor, SEARCH, was set to the default of 20 with extrapolation turned on. The search radius is the maximum distance that a station may be from a grid point to be used in the analysis for that point. The number of passes, NPASS, was set to the default of 2. The scalar grid, GFUNC was defined as the divergence of the u-wind and v-wind using the GEMPAK function div(vecn (uwnd,vwnd)). The other parameters were left blank.

To verify the OABSFC program worked correctly, Dr. Bauman used the GEMPAK program SFMAP to plot the wind arrows from the tower observations and the GEMPAK program GDMAP to plot the divergence based on the gridded wind tower observations as shown in Figure 10. Areas of convergence are shown by blue dashed lines and areas of divergence are shown by red solid lines. Overlaying the wind arrows from the tower observations confirms the strongest convergence area should be over CCAFS where a sea breeze is observed resulting in onshore flow interacting with general northerly winds over KSC and reaching northern and western CCAFS.

Contact Dr. Lisa Huddleston at lisa.l.huddlestoln@nasa.gov or 321-861-4952 for more information.

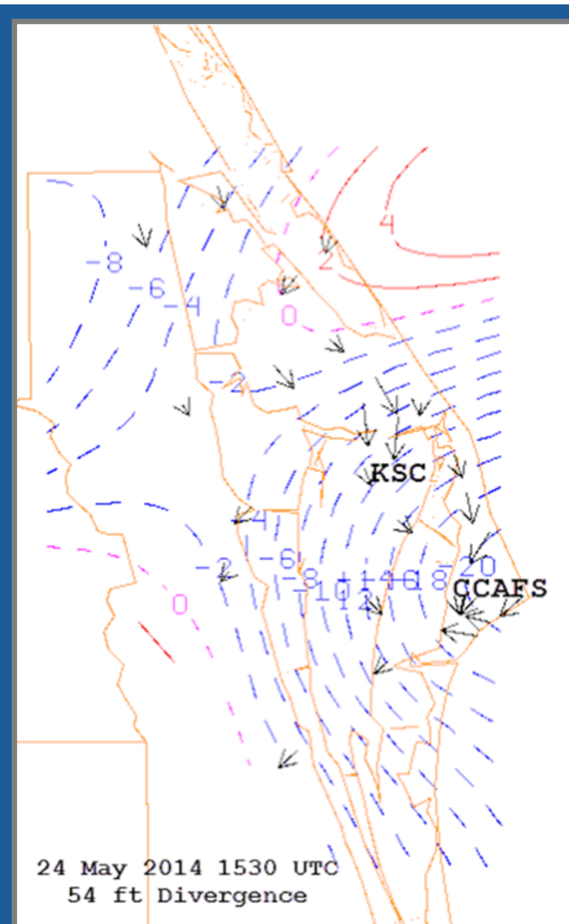


Figure 10. GEMPAK plot of wind arrows (black) from wind tower observations and divergence (10^{-5} sec^{-1}) from 24 May 2014 at 1530 UTC. Areas of convergence are shown by blue dashed lines and areas of divergence are shown by red solid lines.

Range-Specific High-Resolution Mesoscale Model Setup: Optimization (Dr. Watson)

The ER and WFF require high-resolution numerical weather prediction model output to provide more accurate and timely forecasts of unique weather phenomena that can affect NASA's SLS, LSP, and GSDO daily operations and space launch activities. Global and national scale models cannot properly resolve important mesoscale features due to their horizontal resolutions being much too coarse. A properly tuned high-resolution model running operationally will provide multiple benefits to the launch community. This is a continuation of a previously customer-approved task that began in 2012 in which the AMU tuned the WRF model for the ER and WFF by determining the best model configuration and physics for the ER and WFF. The task continued in 2013 to provide a recommended local data assimilation (DA) and numerical forecast model design, which is a cycled DA and modeling system using the GSI and WRF software with scripts provided by NASA's Short-term Prediction Research and Transition Center (SPoRT). In this part of the task, the AMU ported GSI/WRF code to the AMU real-time cluster to run every three hours and display real-time output of the GSI/WRF cycled runs on the AMU's AWIPS workstations. The AMU will work with NASA SPoRT to determine if the GSI/WRF can be run in a rapid-refresh mode. If so, the AMU will determine the time needed to set up the rapid-refresh system and will implement it if possible within the time frame of this task. In addition, the AMU will explore ensemble modeling using the WRF model and will determine the level of effort to set up an ensemble modeling system.

Real-time GSI/WRF Scripts

Dr. Watson began running the GSI/WRF scripts in real-time on the cluster. Ms. Shafer wrote a script to pull the GSI/WRF output from the cluster to be displayed on AWIPS. The model ran successfully for approximately one month and then began to fail during each model run. Dr. Watson is continuing to investigate and troubleshoot the problem.

Dr. Watson began looking into the availability of hourly observation files used to initialize the GSI/WRF model in order to run the model in rapid-refresh mode.

Contact Dr. Lisa Huddleston at lisa.l.huddlestoln@nasa.gov or 321-861-4952 for more information.

Technical Interchange

Dr. Bauman, Ms. Crawford and Ms. Shafer attended the 95th Annual Meeting of the American Meteorological Society in Phoenix, Arizona from 4-9 January. Dr. Bauman was the Program Chair for the 17th Aviation Range and Aerospace Meteorology (ARAM) Conference, which included over 90 oral and poster presentations. Ms. Crawford and Ms. Shafer co-chaired oral presentation sessions at the ARAM Conference. Dr. Bauman represented NASA and ENSCO as a member of the ARAM Committee and attended the annual committee meeting on 6 January. Dr. Bauman presented Dr. Watson's paper "High-Resolution Mesoscale Model Setup for the Eastern Range and Wallops Flight Facility" at the 19th Conference on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface on 8 January. AMU staff participated in several impromptu meetings with AMU partners including Dr. Gary Jedlovec, Dr. Geoffrey Stano, and Mr. Jon Case from NASA's SPoRT Center, Dr. Tsengdar Lee from NASA HQ, and Mr. BJ Barbré from NASA's Marshall Space Flight Center Natural Environments Branch.

Dr. Bauman and Ms. Crawford participated in a technology transition meeting on 13 January with Dr. Antti Pulkkinen representing the Space Weather Research Center (SWRC), and Mr. Marlo Maddox representing the Community Coordinated Modeling Center (CCMC), both from Goddard Space Flight Center. Dr. Pulkkinen and Mr. Maddox were interested in the AMU technology transition process, which they read about in the 2013 peer-reviewed paper published in Space Weather Magazine. The AMU presented the AMU overview briefing and Dr. Pulkkinen and Mr. Maddox presented briefings on the SWRC and CCMC. Following the briefings, Dr. Pulkkinen and Mr. Maddox toured the AMU and RWO.

Dr. Bauman and Ms. Crawford attended a briefing about lightning cessation presented by Florida State University on 14 January, which is a difficult operational forecast problem at KSC/CCAFS. This research was funded by the 45 WS.

Dr. Bauman and Ms. Crawford participated in a telecon with Dr. Kathryn Keeton, the NASA@work Lead from the Center of Excellence for Collaborative Innovation (CoECI) at Johnson Space Center. Dr. Keeton and her colleague, Mr. Steve Rader, CoECI Deputy Manager, met the AMU staff at the 2014 KSC Innovation Expo in September. They wanted to understand the AMU mission and then present a briefing on CoECI capabilities. CoECI works across NASA and other federal agencies to infuse crowdsourcing methods as a set of available tools for engineers and scientists on projects where applicable. Dr. Keeton thought the AMU technology transition process might benefit from CoECI activities. If funding is available, this might be a resource for the KSC Weather Office or AMU customers to use if their proposed work is not tasked to the AMU.

On 29 January, Ms. Shafer and Dr. Bauman participated in the 45 WS monthly LWO training meeting. Ms. Shafer gave a presentation titled "Real-time AMU-WRF High-resolution Model". She discussed how the WRF model is set up and that it is running in a rapid-update cycle every hour, what the new AMU-WRF domains will look like, some verification statistics for the 1.33-km model domain, and then explained how to access the output in AWIPS.

Ms. Crawford, Ms. Shafer, and Dr. Bauman presented the AMU overview briefing to 45 WS Capt's Wright and Godoy. Capt Wright is the new 45 WS Systems AMU liaison and Capt Godoy recently joined 45 WS Systems.

Ms. Shafer and Dr. Watson wrote a paper on the locally tuned AMU-WRF model that they submitted for the KSC 2015 Research & Technology Report. The paper details the configuration and implementation in real-time of the AMU-WRF model.

Launch Support

Ms. Crawford and Dr. Bauman supported the 45 WS Launch Readiness Review (LRR) for the Atlas 5 launch of the MUOS satellite on 16 January. Dr. Bauman, Ms. Shafer, and Ms. Crawford attended the 45 WS LRR on 6 February for the SpaceX Falcon DSCOVR launch. Dr. Bauman, Ms. Crawford, and Ms. Shafer attended the 45 WS LRR for the Atlas MMS launch. Ms. Crawford and Ms. Shafer attended the 45 WS LRR on 23 March for the Delta 4 GPS launch.

Suspicious reflectivity appeared on the weather radar display during the last hour of the Atlas 5 launch countdown on 20 January. The signatures were moving from the northwest, consistent with the wind flow, and were expected to be over the pad at T-0. There was nothing similar to the reflectivity pattern on satellite imagery. The 45 WS radar LWO suspected it was chaff and Ms. Shafer offered an AMU final report with a list of ways to help identify it. After further discussion and adjusting the radar sensitivity thresholds, the launch team was convinced the reflectivity was chaff that would not affect the mission.

During the Atlas 5 launch on 20 January, Dr. Bauman created an AMU-WRF model forecast product of percent cloud cover in the 10,000–30,000 foot layer to assist the 45 WS LWO, who was interested in the amount of cloud forecast at T-0 in the vicinity of the freezing level to support the thick cloud and triggered lightning launch commit criteria. The AMU-WRF model forecast the clouds to clear by T-0, which they did.

During the DSCOVR launch attempt on 8 February, the LWO noted that the LSP Upper Winds Tool wind speed graph was not properly scaling

the wind speeds and he notified Dr. Bauman. It was scaling the maximum winds over 130 kt, yet the maximum winds in the layer surface to 70,000 ft were about 70 kt. This occurred because it was scaling to the maximum speed in the model data, which was over 130 kt at 125,000 ft. Dr. Bauman updated the tool to truncate all sensor and model data at about 70,000 ft so the wind speed scale would accurately represent the wind speeds up to this altitude.

During the DSCOVR launch attempt on 10 February, there was an issue with strong upper-level winds that ultimately scrubbed the launch due to vehicle loads violations. During the count, the launch director asked the LWO if the LSP Upper Winds Tool could display the forecast winds for the next launch attempt on 11 February. The original AMU task only required the tool to display forecast winds during a launch countdown, not a 24-hour forecast. Dr. Bauman added a “Planning Forecast” option to the tool that provides 21, 24, 27, and 30 hour forecasts from the Global Forecast System model and delivered it to the 45 WS within two hours of the request. The LWO was able to use the new capability to brief the launch director.

In the early stages of the launch count for the Delta 4 GPS, one of the LWOs asked for assistance with the Upper Winds Tool. The version on the Air Force computer would not display the profiler data due to a computer system upgrade. Dr. Bauman modified the code that was not compatible with the upgrade, resulting in the tool working properly. Ms. Crawford and Dr. Bauman took steps to get the updated tool on 45 WS network. Ms. Crawford watched as the LWOs tested the new version to ensure it worked properly. This action gained praise from the LWOs during the hotwash after the launch..

Forecaster Support

At the start of the Falcon 9 CRS 5 operation on 10 January, AWIPS data displays were not current and had not been updated in several days. Ms. Crawford followed instructions in an AMU standard operating procedure (SOP), but was unable to resolve the issue. She contacted Mr. Magnuson of ENSCO and informed him that AWIPS was not updating and sent him the SOP showing what had been done in an attempt to fix the issue. Mr. Magnuson found that an AWIPS server disk had filled up. He fixed all issues, and Ms. Crawford restarted AWIPS in the AMU lab and in RWO.

On 14 January Ms. Shafer visited the 30 OSS at VAFB in California. NASA’s LSP and other programs at VAFB use forecasts issued by the 30 OSS for daily and launch operations. Because of this, it is important for the AMU to understand the 30 OSS operations as part of their technology transition process. Ms. Shafer met with Mr. Tyler Brock, one of the 30 OSS launch weather officers, to discuss potential AMU tasks. Topics included the optimization of the AMU-WRF model over the Western Range and expanding the AMU wind tower climatology tool to include additional years and sensor levels. Ms. Shafer toured the operations floor and met with the forecasters to understand their requirements. The site visit allowed direct interaction between the AMU and 30 OSS, which resulted in a stronger working relationship.

Ms. Shafer attended a meeting with the 45 WS on 22 January that addressed comparing data from the new Mesoscale Eastern Range Lightning Interferometer Network (MERLIN) and Lightning Detection and Ranging (LDAR) systems. The systems do not measure lightning the same way, so it is important to know the detection efficiency of each before the 45 WS can recommend that MERLIN replace LDAR. The 45 WS discussed possible analysis methods and suggested the AMU do this work. The 45 WS will investigate if any other group is scheduled to do a comparison and if not, will discuss further with the AMU.

Ms. Shafer set up the new AMU-WRF with expanded model domains to run in real-time. This will help the 45 WS forecasters better track the west coast sea breeze before it impacts KSC/CCAFS and monitor tropical cyclones near the east coast of Florida. It will also provide high resolution model forecasts for NWS MLB over their entire county warning area.

Dr. Bauman completed the LSP Upper Winds Tool upgrade to include implementation of the algorithm to splice the 915-MHz Doppler Radar Wind Profiler (DRWP) with the 50-MHz DRWP now that the new 50-MHz DRWP is providing real-time data. He delivered the software to the 45 WS on 30 January. Testing on the 45 SW network resulted in security errors that would not permit the download of files from the Spaceport Weather Archive (SWA) server, which supplies all of the files for the tool. After considerable troubleshooting with the 45 WS, Lt Col Doser, 45 WS Operations Officer, suggested changing the HTTP call to the server. This change allowed the files to be downloaded. However, some files were missing from the SWA server. Dr. Bauman notified Mr. Gemmer of Abacus Technology, who discovered an issue with the file capture on the SWA server from the 45 SW Range External Interface Network (REIN). Mr. Gemmer submitted a request to KSC Information Management Communications Support (IMCS) who resolved the issue. Additionally, there were times when the SWA server and public website were down, which caused the tool to fail. Dr. Bauman again notified Mr. Gemmer, who determined there could be failures on one of the server nodes.

Ms. Shafer was notified by Mr. Blottman of NWS MLB that it was unlikely the Weather Events Simulator software for AWIPS would be ready for implementation anytime within the next 4-6 months. Therefore, Dr. Huddleston agreed that Ms. Shafer should pursue an interim task to update the VAFB Weather Tower Climatology as proposed by 30 OSS. She wrote a response to the 30 OSS proposal, which was approved by Dr. Huddleston and 30 OSS. She then wrote an updated AMU Task Plan.

Ms. Crawford completed the review process for the Weak Waterspout memorandum. Dr. Huddleston reviewed the final version and provided a signed approval. After receiving the approval, Ms. Crawford created a PDF version by combining the 45 WS checklist with the memo, and then distributed the memo to the 45 WS.

Dr. Bauman presented a review of the AMU LSP Upper Winds Tool and AMU Waterspout tool to the 45 WS LWOs during their February training day. Ms. Crawford discussed the findings from her Weak Waterspout memorandum. Because there have been ongoing issues with accessing the files required for both tools from the SWA, Maj Sweat suggested looking into pulling the model forecast files from the AFWA instead of Iowa State University via the SWA for the LSP Upper Winds Tool. AFWA could provide two of the three models currently used by the tool. While Maj Sweat's suggestion could make accessing two of the model files more reliable, the tool still requires access to the SWA server for the 50 MHz and 915 MHz DRWP data and CCAFS rawinsonde data. The LWOs also expressed interest in adding the AMU-WRF to the model selection. Based on the Waterspout discussion and Ms. Crawford's findings, the consensus is that the tool and 45 WS checklist need to be updated. Ms. Winters suggested doing so prior to the warm season start in May.

SSgt HIdebrandt, a 45 WS forecaster, requested help displaying model forecast soundings on AWIPS because they were unavailable via the AFWA web service. Dr. Bauman gave him a step-by-step tutorial and then created an AWIPS Procedure so the forecasters could access the soundings with a couple of mouse clicks.

Data Access and Display

Dr. Bauman started ingesting Florida surface weather observations from the NOAA Meteorological Assimilation Data Ingest System (MADIS) for display on the AMU and RWO AWIPS. MADIS provides surface weather observations every minute instead of every hour for the standard reporting stations. MADIS leverages partnerships with international agencies; federal, state, and local agencies; universities; volunteer networks; and the private sector to integrate observations from their stations with those of NOAA to provide finer density higher frequency observations for use by the meteorological community.

Dr. Bauman provided two sets of KSC 50-MHz DRWP test files from the 45 WS Meteorological Interactive Data Display System (MIDDS) to Mr. Wilfong of DeTect, Inc. so he could compare the MIDDS files with those sent from the DRWP to ensure they were identical. This is part of the acceptance testing of the new DRWP.

The AMU MERLIN computer was unable to display data because the existing monitor provided by the vendor was not compatible with the converter box NASA is using to send MERLIN video to KSC. The AMU had a compatible spare monitor that Dr. Bauman loaned to the 45 WS until they could procure a replacement monitor. The data is once again being displayed on the AMU MERLIN system and being sent to KSC.

IT

Mr. Magnuson and Ms. Shafer continued to reconfigure the two NASA AMU modeling clusters to run the AMU-WRF and GSI/WRF in real-time and display in AWIPS.

One of the IMCS Data Center Services System Architects, Jim Fitzgerald, notified the AMU that the modeling clusters were causing an imbalance in power usage regularly at the top of each hour for the past few weeks. The power imbalance was causing alerts indicating the UPS was experiencing a near overload threshold violation. To mitigate this condition, Ms. Shafer tried running the AMU-WRF real time model on 9 nodes instead of all 12 until a long term solution could be addressed.

Mr. Magnuson, Ms. Shafer, and Dr. Bauman worked with the IMCS Data Center Services System staff to change the power loading of the AMU modeling clusters by accessing power for several of the nodes from the rack adjacent to the modeling clusters rack. They had to power-down both clusters, move the power cables, and restart both systems locally in the KSC Data Center. After moving the power cables, the IMCS staff stated the power was balanced. Ms. Shafer began running the real time AMU-WRF and GSI/WRF.

Ms. Shafer and Dr. Bauman continued to prepare for the AMU IT Security Plan reassessment by registering the AMU System in the Privacy and Controlled Unclassified Information (CUI) Assessment Tool (PCAT) and the System for Tracking and Registering Applications and Websites (STRAW). They successfully added the AMU System to PCAT but had to request access to STRAW and were awaiting approval.

Dr. Bauman and Ms. Shafer met with Mr. Mack from GP-G IT Security and Dr. Huddleston to review the status of the AMU IT System Security Plan (SSP) before presenting it to KSC IT Security for renewing the Authority to Operate (ATO). System ATOs are valid for three years and the AMU ATO expired on 29 March 2015. Based on this meeting, Ms. Shafer and Dr. Bauman updated the AMU SSP sections on the NASA ITSC website and the AMU SSP is now ready for ATO review. Mr. Mack stated he would setup the ATO meeting with Ms. Kniffin from KSC IT Security Office prior to 29 March. This meeting was never scheduled, therefore Dr. Huddleston requested an Emergency ATO for the AMU System, which was granted by KSC IT Security and all responsibility for the AMU System was transferred to Mr. Mack due to the AMU contract ending on 30 April.

Dr. Watson and Ms. Shafer corresponded with Dr. Rozumalski of NOAA about instability issues in the AMU-WRF EMS model that caused the model to occasionally fail. After testing, Dr. Rozumalski determined that there was a bug in the WRF

code causing the instability. He provided a solution to the problem and will have an official fix in the next version of the software.

Visitor Briefings

Ms. Maier from the KSC Weather Office and Mr. Anderson from LSP observed the AMU support to the 45 WS during the SpaceX Falcon 9 ABS-Eutelsat launch. Dr. Bauman provided an overview of the AMU to Mr. Anderson. Lt Col Doser described the roles of each 45 WS Launch Weather Team position and provided examples of how various AMU technologies are used during launch support. Mr. Craft demonstrated the AMU Anvil Tool and Mr. McAleenan demonstrated the LSP Upper Winds Tool.

Mr. Anderson asked if the AMU could provide high resolution satellite imagery from AWIPS to NASA's operations in Hangar AE on CCAFS. Mr. Divertie from LSP has been working on a requirement to upgrade the weather displays for NASA and efforts to do so using 45 WS displays have been unsuccessful. Dr. Bauman put Mr. Divertie in contact with Mr. Magnuson from ENSCO, who is ENSCO's AWIPS systems/software engineer. Mr. Magnuson and Ms. Shafer worked with Mr. Divertie and Mr. Tucker, also of LSP, to set up a virtual network connection to AMU AWIPS so LSP could receive high-resolution satellite imagery in Hangar AE. While testing, Ms. Shafer invited Mr. Divertie and Mr. Tucker to tour the AMU lab and discuss available AWIPS products. They agreed AWIPS was a powerful resource and the images seen in Hangar AE are significantly better than what was available previously. After testing a technical solution to send AWIPS graphics to NASA LSP in Hangar AE, Dr. Bauman, Ms. Crawford, Ms. Shafer, and Mr. Magnuson visited Mr. Divertie to tour the facility and see how LSP displays weather graphics on day-of-launch. Based on the visit, Mr. Magnuson adjusted the resolution and aspect ratio of the video feed from the AWIPS Virtual Network Computing (VNC) server to the LSP video. For a more permanent short term solution, Mr. Divertie ordered a PC that the AMU will setup as a dedicated AWIPS client for LSP. The computer will be located in the AMU lab area in the Morrell Operations Center (MOC) and will be capable of running VNC software that will send real-time high definition video from the AMU AWIPS to LSP in Hangar AE for launch support. For a long term solution, LSP could task the AMU to develop additional products on AWIPS similar to those used by the 45 WS LWO on day-of-launch.

Ms. Maier and Mr. Simmonds from the GSDO Program observed the AMU support to the 45 WS during the Atlas 5 MMS launch. Dr. Bauman provided an overview of the AMU to Mr. Simmonds. Col Klug, 45 WS Commander, described the roles of each 45 WS Launch Weather Team position and provided examples of how various AMU technologies are used during launch support.

Equipment

Mr. Magnuson, Dr. Bauman and Ms. Shafer replaced the Low Noise Block (LNB) located on the feed horn of the NASA/AMU NOAAPort Receive System (NRS) satellite dish at the MOC on 22 January. Since NOAA increased bandwidth for users of the NRS Satellite Broadcast Network (SBN) in September, the AMU AWIPS had been experiencing data dropouts of large files such as satellite imagery and model data. After replacing the LNB, the signal strength improved and the signal-to-noise ratio decreased and the data dropouts have ceased.

Dr. Bauman responded to Kennedy Laboratory Capabilities Committee (KLCC) Obsolete Equipment Action on 29 January. The KLCC started the process to compile a list of laboratory equipment to be replaced due to obsolescence and requested all KSC laboratories submit their lists by 10 February. Dr. Bauman submitted a request to replace the five-year-old AMU AWIPS servers and clients. The AWIPS hardware was purchased in September 2009 and is beginning to have issues such as memory failures. The new AWIPS II software will run more efficiently on new hardware and the servers will be able to better process the increased amount of data received via the NOAAPort SBN, which quadrupled its bandwidth in September 2014.

Dr. Bauman responded to a KSC Weather Office request to review and update a list of weather instruments, data, displays and communications used for weather support by KSC, 45 WS, AMU, and NWS MLB.

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LIST OF ACRONYMS

30 SW	30th Space Wing
30 OSS	30th Operational Support Squadron
3-D	Three Dimensional
45 RMS	45th Range Management Squadron
45 OG	45th Operations Group
45 SW	45th Space Wing
45 SW/SE	45th Space Wing/Range Safety
45 WS	45th Weather Squadron
AFSPC	Air Force Space Command
AFWA	Air Force Weather Agency
AMU	Applied Meteorology Unit
ATO	Authority to Operate
AWIPS	Advanced Weather Information Processing System
CCAFS	Cape Canaveral Air Force Station
CCMC	Community Coordinated Modeling Center
CoECI	Center of Excellence for Collaborative Innovation
CSR	Computer Sciences Raytheon
csv	Comma Separated Value
CUI	Controlled Unclassified Information
CWA	County Warning Area
DA	Data Assimilation
DRCT	Wind Direction
DRWP	Doppler Radar Wind Profiler
ER	Eastern Range
ERAU	Embry-Riddle Aeronautical University
ESRL	Earth System Research Laboratory
FAA	Federal Aviation Administration
FSU	Florida State University
GEMPAK	GEneral Meteorology PAcKage
GP-G	Ground Systems Division
GSDO	Ground Systems Development and Operations program
GSI	Gridpoint Statistical Interpolation
JSC	Johnson Space Center
KSC	Kennedy Space Center
LDAR	Lightning Detection and Ranging
LNB	Low Noise Block
LRR	Launch Readiness Review
LSP	Launch Services Program
LWO	Launch Weather Officer
MADIS	Meteorological Assimilation Data Ingest System
MCO	Orlando International Airport
MERLIN	Mesoscale Eastern Range Lightning Interferometer Network
MIDDS	Meteorological Interactive Data Display System
MOC	Morrell Operations Center
MSFC	Marshall Space Flight Center
NCAR	National Center for Atmospheric Research
NOAA	National Oceanic and Atmospheric Administration
NRS	NOAAPort Receive System
NSSL	National Severe Storms Laboratory
NW	Northwest
NWS MLB	National Weather Service in Melbourne, Florida
PCAT	Privacy and CUI Assessment Tool
POR	Period of Record
QC	Quality Control
REIN	Range External Interface Network
RMSE	Root Mean Square Error
RWO	Range Weather Operations
SBN	Satellite Broadcast Network
SE	Southeast
SKNT	Wind Speed in Knots
SLS	Space Launch System
SMC	Space and Missile Center
SPoRT	Short-term Prediction Research and Transition Center
SSP	System Security Plan
STRAW	System for Tracking and Registering Applications and Websites
SWA	Spaceport Weather Archive
SWRC	Space Weather Research Center
TDWR	Terminal Doppler Weather Radar
USAF	United States Air Force
UWND	U-component of the wind
VAFB	Vandenberg Air Force Base
VBA	Visual Basic for Applications in Excel
VNC	Virtual Network Computing
VWND	V-component of the wind
WDSS-II	Warning Decision Support System–Integrated Information
WFF	Wallops Flight Facility
WRF	Weather Research and Forecasting Model
WRF-EMS	WRF Environmental Modeling System
WSR-88D	Weather Surveillance Radar–1988 Doppler
WTCT	Weather Tower Climatology Tool

The AMU has been in operation since September 1991. Tasking is determined annually with reviews at least semi-annually.

AMU Quarterly Reports are available on the Internet at http://science.ksc.nasa.gov/amu/.

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